OSF19-2019-000108

Abstract for an Invited Paper
for the OSF19 Meeting of
the American Physical Society

The Group-IV Approach to Silicon Photonics

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Silicon-based photonic devices such as emitters and detectors have long been desired owing to the possibility of monolithic integration of photonics with high-speed Si electronics and the aspiration of broadening the reach of Si technology by expanding its functionalities well beyond electronics. To overcome the intrinsic problem of bandgap indirectness in the group-IV semiconductors of Si, Ge, and SiGe alloys, a new group-IV material platform silicon-germanium- tin alloy (SiGeSn) has been investigated, featuring compatibility with current CMOS process, capability of monolithic integration on Si, and the tunable bandgap allowing the optoelectronic devices operation covers broad wavelength in near- and mid-infrared ranges. For the past decade, plenty of promising results have been reported, such as GeSn lasers based on direct bandgap GeSn alloys, GeSn light emitting diodes (LEDs) and detectors operating in 2 3 m. With tremendous novel electrical, optical, and mechanical properties, the newly developed GeSn devices could dramatically change the landscape of future microelectronics and photonics. In this plenary talk, I will present the latest development in photonic devices based on such a group-IV material system including infrared photodetectors, focal plane arrays, light emitting diodes, and optically pumped lasers. In addition, I will also talk about a more futuristic approach with the SiGeSn system for the development of THz quantum cascade lasers that can be potentially integrated on Si substrate.